LANSCE
Los Alamos Neutron Science Center

Research Proposal for the use of Neutron Science Facilities

☐ Fast Access ☐ Joint CINT Proposal

Proposal Number: 20111526
Submission Number: S1562
Date Received: 03/09/11

Program Advisory Subcommittee: Nuclear Technology
Focus Area:

Flight Path/Instrument: 1FP05-A / ER1
Estimated Beam Time (days): 45
Days Recommended: 0
Dates Desired:
Impossible Dates:

TITLE
High precision measurement of the U-234 neutron-induced fission cross section

☐ Continuation of Proposal #:

☐ Ph.D Thesis for:

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RESEARCH AREA		FUNDING AGENCY
☐ Biological and Life Science	☐ Mat'l Science (incl Cond Matter)	☐ DOE/BES
☐ Chemistry	☐ Medical Applications	☐ DOE/OBER
☐ National Security	☐ Nuclear Physics	☐ DOE/NNSA
☐ Earth Sciences	☐ Polymers	☒ DOE/NE
☐ Engineering	☐ Physics (Excl Condensed Matter)	☐ DOE/SC
☐ Environmental Sciences	☐ Instrument Development	☐ DOE/Other
☒ Nuc. Physics/chemistry	☒ Neutron Physics	
☐ Astrophysics	☒ Fission	☐ DOD
☐ Few Body Physics	☒ Reactions	☐ NSF
☐ Fund. Physics	☐ Spectroscopy	☐ Industry
☐ Elec. Device Testing	☐ Nuc. Accel. Reactor Eng.	☐ NASA
☐ Dosimetry/Med/Bio	☐ Def. Science/Weapons Physics	☐ NIH
☐ Earth/Space Sciences	☐ Radiography	☐ Foreign:
☐ Materials Properties/Test	☐ Threat Reduction/Homeland Sec.	
☐ Other:	☐ Other:	☐ Other US Gov't:
		☐ Other:

PUBLICATIONS

Publications:

4FP90L:
F. Tovesson, T. S. Hill, Cross section for 239,241Pu(n,f) in the range En= 0.01 eV to 200 MeV, Nucl. Sci. Eng. (in press).
J. D. Baker, C. A. McGrath, T. S. Hill, R. Reifarth, F. Tovesson, Actinide Targets for Neutron Cross Section Measurements, J. Radioanalytical Nucl. Chem. 276, 555 (2008).
F. Tovesson, T. S. Hill, Neutron Induced Fission Cross Section of 237Np from 100 keV to 200 MeV, Phys. Rev. C 75, 034610 (2007).

1 F P 5 :
F. Tovesson, T. S. Hill, M. Mocko, J. D. Baker, C. A. McGrath, Neutron Induced Fission of 240,242Pu from 1 eV to 200 MeV, Phys. Rev. C 79, 014613 (2009).
R. Sanchez, J. Bounds, D. Hayes, T. Grove, F. Tovesson, Measurement of the Thermal Absorption Cross Section in Lucite Using Fermi Age Theory, Nucl. Sci. Eng. 162, 253 (2009).
F. Tovesson, T. S. Hill, Sub-threshold Fission Cross Section of 237Np, Nucl. Sci. Eng. 159, 83 (2008).
M. Mocko, G. Muhrer, F. Tovesson, Advantages and limitations of nuclear physics experiments at an ISIS-class spallation neutron source, Nucl. Instr. and Meth. A 589, 455 (2008).
G. Muhrer, T. S. Hill, F. Tovesson, E. Pitcher, Comparison of the measured and the calculated total thermal cross section of Pb, Nucl. Instr. and Meth. A 572, 866 (2007).

Abstract: S1373_fission_cros.pdf

By electronic submission, the Principal Investigator certifies that this information is correct to the best of their knowledge.

Safety and Feasibility Review *(to be completed by LANSCE Instrument Scientist/Responsible)*

☐ **No further safety review required** ☐ **To be reviewed by Experiment Safety Committee**

☐ **Approved by Experiment Safety Committee, Date:**

Recommended # of days:	**Change PAC Subcommittee and/or Focus Area to:**	**Change Instrument to:**

Comments for PAC to consider:

Instrument scientist signature: **Date:**

High precision measurement of the U-234 neutron-induced fission cross section

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F-. J. Hambsch, *IRMM, Geel, Belgium*

Introduction

The future nuclear reactor fleet is expected to include fast spectrum reactors as a means of closing the nuclear fuel cycle. Fuel Cycle Research and Development (FC R&D) is a Department of Energy (DOE) program whose mission is to develop the fuel cycle technologies that will meet the need for economic and sustained nuclear energy production while satisfying requirements for controlled, proliferation-resistant nuclear materials management and is focused on fast reactor technologies for the recycling mission. The FC R&D program includes efforts to identify and quantify the nuclear data needs for a number of candidate reactor concepts and a nuclear data measurement program to deliver these priority data[1]. These fast reactor sensitivity studies have revealed the need for decreasing the uncertainties associated with actinide fission cross sections in the fast region[2]. Using techniques developed in earlier experiments[3,4,5,6] at the Los Alamos Neutron Science Center (LANSCE), a new high precision cross section measurement of U-234 will be performed to meet those needs.

U-234 is important in the nuclear fuel cycle, since it is transmuted to U-235 through neutron capture and also contributes to the long term waste issue of spent fuel. It is therefore of interest to further reducing the uncertainties of the fission cross sections of this isotope, particularly in the fast neutron region.

Experimental method

The measurements will be performed at the LANSCE neutron source using the time-of-flight method to determine the incident neutron energies. Ionization chambers will be used for the fission counting by detecting the energy deposited in the chambers by fragments escaping from thin actinide samples. Both the WNR facility and Lujan Center will be utilized to cover the fast energy range.

Fission will be detected using parallel-plate ionization chambers. These chambers are operated in pulse mode, and provide fast timing signals and good energy resolution. Thin (<200 ug/cm^2) fissionable samples are placed on a cathode plate kept at negative voltage (nominally -300 V). The readout plate (the anode) is kept at ground, and is read out with a current sensitive preamplifier. The plate spacing is 12 mm, and the chamber is filled with P-10 gas (90% argon + 10% methane) at about 24 PSI. In this configuration most of the fission fragments only deposit some fraction (about 1/3 on average) of their energy in the gas, which improves the separation between fission and decay alphas from the more active samples. The ratio between the fission fragment and alpha specific energy loss is much higher at the beginning of their track than at the end, so by only collecting the energy deposited at the beginning of the track the ability to distinguish alpha particles from fission fragments is enhanced.

Each ionization chamber can hold up to four samples, so up to four channels are in use simultaneously. The RIS Corp. preamplifier used to read out the anodes are high gain (nominal gain of 1000) and are current sensitive, with a very short decay constant compared to the charge collection time of the detector. The preamplifier output signal has a rise time of about 20 ns, and the time before the baseline is restored is about 230 ns corresponding to an electron drift velocity of 60 mm/us in P-10 at these voltages and pressures. The timing of the fast preamplifier signals are picked off with a constant fraction discriminator, which provides sub-nanosecond timing resolution.

All fission cross section measurements are performed relative to a standard U-235 sample in the chamber. The $^{235}U(n,f)$ cross section is considered a standard for neutron flux measurements at 25.3 meV and from 150 keV to 200 MeV This reaction was also used as flux monitor at energies where it is not considered a standard for neutron flux measurements.

The U-234 sample will be supplied by the Institute for Reference Material and Measurements (IRMM) in Geel, Belgium. It is 200ug/cm^2 thick, with a total amount of U-234 of about 1.5 mg. The enrichment is in excess of 99%.

Beam request

- We request 3 days for setup and 21 days of production running on the 4FP90L flight path.
- 3 days of setup and 42 days of production running is requested for the 1FP5 flight path.

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[1] G. Aliberti, W.S. Yang and R.D. McKnight, Nuclear Data Sheets **109**, 2745 – 2751 (2008).
[2] G. Aliberti, G. Palmiotti, M. Salvatores, T. K. Kim, T. A. Taiwo, M. Anitescu, I. Kodeli, E. Sartori, J. C. Bosq and J. Tommasi, Annals Nucl. Energy **33**, 700 – 733 (2006).
[3] F. Tovesson, T. S. Hill, Nucl. Sci. Eng. (in press).
[4] F. Tovesson, T. S. Hill, M. Mocko, J. D. Baker, C. A. McGrath, Phys. Rev. C **79**, 014613 (2009).
[5] F. Tovesson, T. S. Hill, Nucl. Sci. Eng. 159, **83** (2008).
[6] F. Tovesson, T. S. Hill, Phys. Rev. C **75**, 034610 (2007).